

**Independent System for Peer Reviews**

**Consultant Report on:**

**Canary Rockfish and Arrowtooth Flounder Stock Assessment  
Review (STAR) Panel**

**July 30 – August 3, 2007 Seattle, Washington**

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## Executive Summary

The STAR panel review, which is the subject of this report, covered the 2007 stock assessments for the canary rockfish (*Sebastes pinniger*) and arrowtooth flounder (*Atheresthes stomias*) resources off the west coast of the United States. The Stock Assessment and Review (STAR) Panel of the Pacific Fishery Management Council (PFMC) met in Seattle, Washington 30 July - 3 August 2007. This report does not repeat findings of the main STAR panel report, but provides more details on important issues arising from the meeting. The main points can be summarised as follows:

- The canary rockfish and arrowtooth flounder assessments should take greater account of the degree to which they are shared with Canada.
- Continued improvements could be made in standardising the abundance surveys, correcting for seasonal and other effects on catchability, and in particular taking account of what fishermen consider important.
- A simulation study should be used to determine the best way to tune the recruitment deviate standard deviation and identify a suitable start year for estimating recruitment deviates.
- The likelihood profile for canary rockfish should be excluded from the prior used for other species.
- There should be closer co-operation between Gulf of Alaska and the west coast stock assessment scientists for the assessments of the two arrowtooth flounder stocks.
- If size specific natural mortality is to be used, the Lorenzen (2005) model is recommended rather than discontinuous breaks in the mortality rates.
- Given the common data collection methods, models and decision rules being used across assessments, and the possible requirement for a less data-demanding approach, it would be worth considering a review of the overall strategy for the assessment and management of west coast stocks.

## **Background**

The STAR panel review, which is the subject of this report, covered the 2007 stock assessments for the canary rockfish (*Sebastes pinniger*) and arrowtooth flounder (*Atheresthes stomias*) resources off the west coast of the United States.

Canary rockfish are most abundant from British Columbia to central California where they are predominantly found along the continental shelf shallower than 300m. Since the overfished determination in 2000, canary rockfish have become a limiting species as bycatch for many continental shelf fisheries.

Arrowtooth flounder are an abundant flatfish common from the Bering Sea to Northern California in depths from 50 to 800m. Landings of arrowtooth flounder have been limited by a lack of market and quotas on bycatch, and catches have only exceeded MSY levels in one year (1999) in the last decade. The first full age structured stock assessment was presented at this meeting.

The information from the stock assessments incorporating the review is provided to the Pacific Fishery Management Council and NOAA's National Marine Fisheries Service to be used as the basis of their management decisions, which are subsequently approved and disseminated by the Secretary of Commerce through NOAA and NMFS.

## **Review Activities**

The stock assessment documents were received prior to the meeting and consisted of the stock assessment reports and considerable background material on compact disk (See Annex I Bibliography). The Stock Assessment and Review (STAR) Panel of the Pacific Fishery Management Council (PFMC) met in Seattle, Washington 30 July - 3 August 2007, to review the canary rockfish and arrowtooth flounder stock assessments. The meeting included presentations of the assessments and requests from the panel to the STAT teams to conduct additional fits and analyses to identify a suitable base model and axis of uncertainty.

The Stock Assessment Review (STAR) meeting was a formal, public, multiple-day meeting of stock assessment experts. The review panel was made up of five experts, including two external CIE reviewers. The STAT team also attended the meeting and presented the stock assessments. Other scientists and stakeholders were present to observe and comment on the assessment. This report is based upon a review of the documents received, some analyses of data and discussions at the meeting, providing personal emphasis and more detail on some issues than available in the STAR panel report. This report does not repeat findings of the main STAR panel report, which needs to be consulted for the panel's views on these assessments.

## **Assessment Data**

### **Summary of Findings**

There are various sources of information which were used in both stock assessment models: the fishery dependent total catches, length and age compositions, and the fishery independent trawl survey biomass index, length and conditional age-at-length compositions.

The uncertainties associated with the shared stock status with Canada are probably covered by the uncertainty mapped out for the assessments. Stock structure was not

discussed at any length during the panel meeting as there was little that could be done by the STAT team at such a late stage in the assessment. However, if the international political boundary did not exist, it is unlikely that scientists would draw an arbitrary stock boundary at the US-Canadian border.

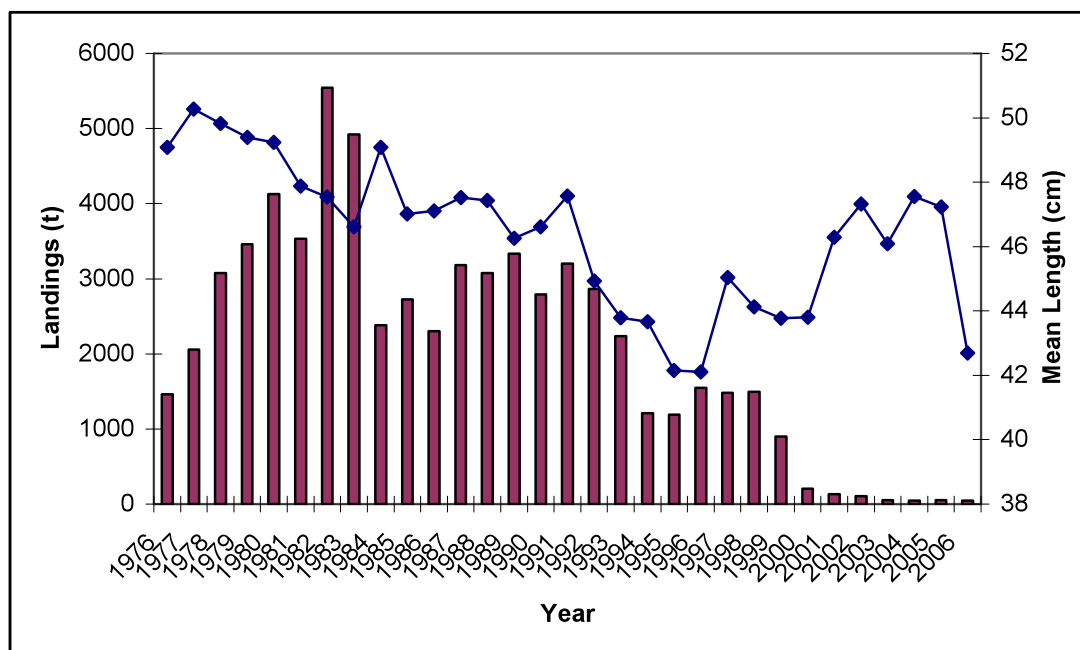
Given the pattern in the triennial survey residuals and the distinct break in the way the survey was conducted, the assessment could only use the series broken into two distinct periods. Fortunately for the species considered in this assessment, this is probably not a critical issue as the survey appears to have little impact on the results.

The quantity of arrowtooth flounder age data was too small and noisy to follow individual cohorts. Arrowtooth flounder is a top predator, and it is likely to become more important as ecosystem models are developed. More age data collection on this species may be warranted despite having a low economic value, as its importance in a food web model would be high.

The underlying data in the canary rockfish assessment is difficult to interpret. No cohorts are apparent in the age data, which appears to be dominated by noise. Age data appear to be most useful for estimating growth through conditional length-at-age.

The canary rockfish length data strongly influences the model results. The average length is a summary of the pattern which the model will fit to, a fall in length implying an increase in mortality assuming no other changes (e.g. in selectivity). There was no signal in the Oregon trawl data, but the Washington trawl mean length does change in response to the change in catches (Fig.1). While the trends in decreasing and increasing mean length could be due to changes in mortality, detailed year-to-year changes do not correspond well, and could be due to a combination of other processes such as changes in fishing mortality, recruitment, selectivity, migration to and from Canadian waters as well as observation error (sample sizes are very small, recently based on 200-600 measurements per year). This problem is illustrated by the small mean length (and high standard deviation) for 2006, which cannot be due to changes in mortality, but must be due to some other cause.

As a result of these data limitations, the assessments are more akin to age structured production models than catch-at-age models. This is only a problem in the sense that structural errors in the model may only become apparent when improved data becomes available, and in the meantime the detailed population age structure may appear better estimated than it really is.



**Figure 1** Total catches (histogram) and mean length for canary rockfish in the Washington trawl fishery. Although trends in mean length probably reflect changes in fishing mortality, year-to-year changes are affected by noise and other effects. The 2001-2005 mean length appears to have recovered to the 1985-1991 level.

## Conclusions and Recommendations

The degree to which the canary rockfish and arrowtooth flounder stocks are shared with Canada should be assessed. This would initially involve proposing a null hypothesis for each species as to what can reasonably be considered a management unit (i.e. the stock over which management has control) irrespective of political boundaries. Then, if a joint assessment with Canada is not possible, at the very least, Canadian catches for both species should be included where it is thought appropriate. The STAT team should ignore political boundaries as much as possible and try to address stock structure on scientific not management grounds.

An analysis should be undertaken to ensure the triennial survey can form an unbroken abundance index. A standardisation on the current survey time series data with the day in season as a main effect can be applied. However, concern was expressed that results could be biased as the location was confounded by date across the time series. This could be corrected by at least one more survey designed to provide good estimates from the relevant parameters, separating location from seasonal effect. This would most likely involve surveying repeatedly during the summer a smaller area where the relevant species has been found to be most abundant in previous years. In future, greater care should be taken to ensure survey time series are not compromised.

Survey indices should be standardised covering all covariates likely to affect catchability. The GLMM standardisation presented was well done, but did not include all likely covariates. As well as the seasonal effect described above, other factors such as bottom or surface temperature, and tide state should be considered as covariates affecting catchability. Many of these covariates can be obtained from historical records or calculated from the location, date and time of the haul. Understanding how and by how much these factors affect catchability not only reduces error, particularly bias, in the abundance indices, but also may allow improvements in survey design. It

is also good practice, wherever possible, to take account of fishermen's views on factors affecting catch rates. While changing the survey to follow the fish is not acceptable, correcting for covariates which fishermen believe affect catchability is a useful way to be seen to listen to their concerns without affecting the scientific validity of the results.

Alternative approaches to assessment and decision-making which require less data will be needed to cover the large number of species caught in the west coast fisheries. Currently, the type of model used in assessments is determined at least in part by the indicators and reference points required by management. Such fine details of the population dynamics are probably unnecessary for many species given that the management controls are fairly blunt instruments. The current approach places a heavy demand on data, which will not be available for all species.

## **Estimates of Recruitment**

### **Summary of Findings**

The Beverton and Holt steepness parameter is a useful focus for the uncertainty in a rebuilding assessment. Unfortunately while the steepness parameter will determine the rate at which the canary rockfish stock will recover, it remains highly uncertain.

The panel decided that the available prior represented the only information available on the steepness parameter. The prior used by this assessment is being recalculated from likelihood profiles for other rockfish species. This assumes that these likelihoods contain information on the steepness parameter, which does not appear to be the case for canary rockfish. If all assessment likelihoods are included indiscriminately, the prior is likely to result in "regression towards the mean", with most probability being gathered around the mid point of the range. This is a relatively uninformative prior and not a good estimate of the true steepness.

It was suggested during the meeting that lower steepness might be associated with longer lived, slow growing species. This makes some sense, and if true, could form the basis of a meta-analysis building a prior for steepness conditional on life history parameters such as natural mortality and growth rate. This would also make good use of those few species for which good steepness estimates exist.

There is a clear need to develop a standard acceptable way to estimate the recruitment standard deviation ( $\sigma_R$ ). The standard deviation was originally obtained by tuning the estimate so that the variance across the range of deviates was consistent. This was thought by the panel to underestimate the true recruitment variance, so a compromise was chosen that left the estimate partially tuned (one iteration towards convergence instead of full convergence). The compromise was not entirely satisfactory, although probably better than full tuning.

In the original model, the recruitment deviations were estimated from the start of the catch time series, allowing a "burn-in" period. As expected, deviates only departed from zero when they could influence the age structure to fit the age and length composition data. Starting the deviates at the beginning of the catch time series clearly overfitted the model, but it remained unclear how to determine from when recruitment deviates should be estimated.

## Conclusions and Recommendations

A simulation study should be used to determine the best way to tune  $\sigma_R$  and identify a suitable start year for estimating recruitment deviates. There is no obvious way to estimate either of these two parameters, and no universally consistent or acceptable approach was identified by the panel. Further work based on simulated data would appear to be the only way to develop a robust approach which can be applied consistently.

It may become possible to estimate the steepness for canary rockfish from the data as the stock recovers. Until this is the case, the likelihood profile for canary rockfish should be excluded from the prior used for other species.

## Natural Mortality

### Summary of Findings

Natural mortality was considered the most important source of uncertainty for arrowtooth flounder, but less important for canary rockfish. In neither case could natural mortality be estimated accurately, and estimates were based on longevity. Both species show a difference in sex ratio which might be explained through different natural mortality rates between the sexes.

While estimates based on longevity appears to be the only approach to estimate overall natural mortality, the difference in mortality between the sexes can be estimated from changes in the sex ratio with age. Age data for arrowtooth flounder, where natural mortality estimates were an important source of uncertainty, were insufficient to estimate this difference.

### Conclusions and Recommendations

The difference between the male and female natural mortality of arrowtooth flounder could incorporate a prior from the Gulf of Alaska stock assessment. The age composition data is more extensive for the Gulf of Alaska stock allowing the mortality difference between the male and female to be estimated from the change in sex ratio with age. This would reduce the uncertainty to one natural mortality parameter.

More generally, there should be closer co-operation between Gulf of Alaska and the west coast stock assessment scientists for the assessments of the two arrowtooth flounder stocks. The arrowtooth flounder assessment for the Gulf of Alaska could form the basis for priors for a variety of parameters (e.g.  $K$ ,  $L$ , and  $M$  by sex contingent perhaps on water temperature), where better data exist for that stock.

If size specific natural mortality is to be used, the Lorenzen model (Lorenzen 2005) is recommended rather than discontinuous breaks in the mortality rates. It only requires a single parameter and captures the likely change in mortality in a parsimonious way. The linear ramping of parameters which was used is not a good way to model life history processes as the form of the model has no theoretical or empirical justification.

## Comments on STAR Panel Review Process

A single independent reviewer attending all the STAR panel meetings gave additional value to the panel's comments. Many issues for this meeting were the same as those encountered at other meetings where the assessments used very similar models and



data. Given the common data collection methods, models and decision rules being used across assessments, and the possible requirement for less data-demanding approaches, it would be worth considering a review of the overall strategy for the assessment and management of west coast stocks.

The number of reviewers on the panel was probably more than necessary for carrying out the panel's tasks. There was insufficient time to discuss in detail all issues raised by the five experts and it is very unlikely that the overall conclusions drawn by the panel would have been any different had the numbers of panellists been three or four.

## **References**

Lorenzen, K. (2005) Population dynamics and potential of fisheries stock enhancement: practical theory for assessment and policy analysis. Philosophical Transactions of the Royal Society of London. Fisheries Theme Issue 2004.

## **Annex I Bibliography**

A compact disk was provided with considerable background material. The main documents subject to review were the following:

### **Previous Assessments and STAR Panel Reports**

- A. Status of the U.S. canary rockfish resource in 2005. Richard D. Methot and Ian J. Stewart.
- B. STAR Panel Report for Canary Rockfish. August 15-19, 2005
- C. Follow-Up STAR Panel Report for Canary Rockfish. September 26-30, 2005
- D. Status of the Coastal Arrowtooth Flounder Resource in 1993. Martha H. Rickey. October, 1993.

### **2006 "Off-Year" Workshop Reports**

- A. A Summary Report from the NWFSC Bottom Trawl Survey Workshop held October 31 – November 2, 2006 in Seattle, Washington. NOAA Fisheries, NWFSC, FRAM Division.
- B. A Summary Report from the WC Groundfish Data/Modeling Workshop held August 8-10, 2006 in Seattle, Washington. NOAA Fisheries, NWFSC, FRAM Division.
- C. Report of the Groundfish Harvest Policy Evaluation Workshop, Southwest Fisheries Science Center, La Jolla, California. December 18-20, 2006. A Workshop Sponsored by the Scientific and Statistical Committee of the Pacific Fishery Management Council.
- D. Pre-Recruit Survey Workshop. September 13-15, 2006. Southwest Fisheries Science Center, Santa Cruz, California. A Summary Report Prepared by Jim Hastie NOAA Fisheries, Northwest Fisheries Science Center and Stephen Ralston, NOAA Fisheries, Southwest Fisheries Science Center.

### **SS2 Documentation**

- A. SS2 Zip File – includes User's Manual, example files, and powerpoint presentations
- B. R Software Zip File – Code developed by Ian Stewart to perform model diagnostics and plotting of SS2 output. This is not an official SS2 add-on and is not part of the NOAA toolbox. File contains User's Guide, example files as well as powerpoint presentations.

**Additional Background Materials**

A. GAO Report: Pacific Groundfish: Continued Efforts Needed to Improve Reliability of Stock Assessments. United States General Accounting Office, Report to Congressional Requesters. June 2004.

B. Coastwide Pre-Recruit Indices from SWFSC and PWCC/NWFSC Midwater Trawl Surveys (2001-2006). Stephen Ralston. April 6, 2007.

## **Annex II Statement of Work**

### **Consulting Agreement between Dr. Paul Medley and NTVI**

#### **July 30 – August 3, 2007 Canary Rockfish and Arrowtooth Flounder Stock Assessment Review (STAR) Panel**

##### **General**

The Stock Assessment Review (STAR) meeting is a formal, public, multiple-day meeting of stock assessment experts who serve as a peer-review panel for one or more stock assessments. External, independent review of West Coast groundfish stock assessments is an essential part of the STAR panel process that is designed to make timely use of new fishery and survey data, analyze and understand these data as completely as possible, provide opportunity for public comment, and assure the best available science is used to inform management decisions.

The stock assessments will report the status of the canary rockfish and arrowtooth flounder resources off the west coast of the United States using age and/or size-structured stock assessment models. Specifically, the information includes a determination of the condition and status of the fishery resources relative to current definitions for overfished status, summaries of available data included in the models, and impacts of various management scenarios on the status of the stocks. The information is provided to the Pacific Fishery Management Council and NOAA's National Marine Fisheries Service to be used as the basis of their management decisions, which are subsequently approved and disseminated by the Secretary of Commerce through NOAA and NMFS.

The consultant will participate in the Stock Assessment and Review (STAR) Panel of the Pacific Fishery Management Council (PFMC) for the review of the canary rockfish and arrowtooth flounder stock assessments. The consultant should have expertise in fish population dynamics with experience in the integrated analysis type of modeling approach, using age-and size-structured models, use of MCMC to develop confidence intervals, and use of Generalized Linear Models in stock assessment models.

The Pacific Fishery Management Council's Scientific and Statistical Committee requests that "all review panelists should be experienced stock assessment scientists, i.e., individuals who have done actual stock assessments using current methods. Panelists should be knowledgeable about the specific modeling approaches being reviewed, which in most cases will be statistical age- and/or length-structured assessment models" (SSC's Terms of Reference for Stock Assessments and STAR Panel Process for 2007-2008)

Documents to be provided to the consultants prior to the STAR Panel meeting include:

- Current draft of the canary rockfish and arrowtooth flounder stock assessment;
- Most recent previous stock assessment and STAR panel report for canary rockfish (this is the first assessment of arrowtooth flounder since 1993);

- An electronic copy of the data, the parameters, and the model used for the assessment (if requested by reviewer);
- The Terms of Reference for the Stock Assessment and STAR Panel Process for 2007-2008;
- Summary reports from the West Coast Groundfish “Off-Year” stock assessment improvement workshops held in 2006;
- Stock Synthesis 2 (SS2) Documentation; and
- Additional supporting documents as available.

## **Specifics**

Consultant’s duties should not exceed a maximum total of 14 days: several days prior to the meeting for document review; the 5-day meeting; and several days following the meeting to complete the written report. The report is to be based on the consultant’s findings, and no consensus report shall be accepted.

The consultant’s tasks consist of the following:

- 1) Become familiar with the draft stock assessment and background materials.
- 2) Actively participate in the STAR Panel to be held in Seattle, Washington, July 30 - August 3, 2007. Participants are strongly encouraged to voice all comments during the STAR Panel so the assessment teams can address the comments during the Panel meeting.
- 3) Comment on the primary sources of uncertainty in the assessment.
- 4) Comment on the strengths and weaknesses of current approaches.
- 5) Recommend alternative model configurations or formulations as appropriate during the STAR panel.
- 6) Complete a final report after the completion of the STAR Panel meeting.
- 7) No later than August 17, 2007 submit a written report consisting of the findings, analysis, and conclusions (see Annex I for further details), addressed to the “University of Miami Independent System for Peer Review,” and sent to Dr. David Die, via e-mail to [ddie@rsmas.miami.edu](mailto:ddie@rsmas.miami.edu), and to Mr. Manoj Shivilani, via e-mail to [mshivilani@rsmas.miami.edu](mailto:mshivilani@rsmas.miami.edu).

## **Submission and Acceptance of Reviewer’s Report**

The CIE shall provide via e-mail the final reports of the consultants in pdf format to Dr. Lisa L. Desfosse for review by NOAA Fisheries and approval by the COTR, Dr. Stephen K. Brown by August 31, 2007. The COTR shall notify the CIE via e-mail regarding acceptance of the report. Following the COTR’s approval, the CIE shall provide the COTR with pdf versions of the final report.

### **ANNEX 1: Contents of Panelist Report**

1. The report shall be prefaced with an executive summary of findings and/or recommendations.
2. The main body of the report shall consist of a background, description of review activities, summary of findings (including answers to the questions in this statement of work), and conclusions/recommendations.
3. The report shall also include as separate appendices the bibliography of all materials provided by the Center for Independent Experts and a copy of the statement of work.